Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 7454G
Superseding AMS 7454F

Issued 1-15-57
Revised 7-15-77

BOLTS AND SCREWS, STEEL, LOW-ALLOY, HEAT-RESISTANT
Normalized and Tempered, Roll Threaded
135,000 psi (931 MPa) Tensile Strength

1. SCOPE:

1.1 Type: This specification covers high quality bolts and screws made of a low-alloy, heat resistant steel.

1.2 Application: Primarily for joining parts where high strength up to 900°F (480°C) is required.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) and Aerospace Standards (AS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2373 - Quality Assurance Sampling of Bolts and Screws
AMS 6304 - Steel Bars, Forgings, and Tubing, Low Alloy, Heat Resistant, 0.95Cr - 0.55Mo - 0.30V (0.40 - 0.50C)

2.1.2 Aerospace Standards:

AS 1132 - Design Parameters for Bolts and Screws, External Wrenching, Unified Threaded Inch Series
AS 1177 - Nondestructive Inspection Standards for Bolts and Screws
AS 3062 - Bolts, Screws, and Studs, Screw Thread Requirements
AS 3063 - Bolts, Screws, and Studs, Geometric Control Requirements

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM A370 - Mechanical Testing of Steel Products

2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Standards:

MIL-STD- 794 - Parts and Equipment, Procedures for Packaging and Packing of
MIL-STD-1312 - Fasteners, Test Methods

3. TECHNICAL REQUIREMENTS:

3.1 Material: Shall be AMS 6304 steel, unless otherwise specified.

3.2 Fabrication:

3.2.1 Blanks: Heads shall be formed by hot forging, cold forging, or machining.

3.2.2 Heat Treatment: Headed and machined blanks shall, before finishing the shank and the bearing surface of the head, cold working the head-to-head shank fillet radius when specified, and rolling the threads, be heat treated as follows:

3.2.2.1 Heating Equipment: Furnaces may be any type ensuring uniform temperature throughout the parts being heated and shall be equipped with, and operated by, automatic temperature controllers. The heating medium or atmosphere shall cause neither surface hardening nor decarburization other than that permitted by 3.4.3.2 and 3.4.3.3.

3.2.2.2 Normalizing: Blanks of AMS 6304 shall be unifromly heated to 1750°F ± 25 (954°C ± 15), held at heat for 1 - 1.5 hr, and cooled in still air or in a cooling chamber of the furnace.

3.2.2.3 Tempering: Normalized blanks of AMS 6304 shall be tempered by heating uniformly to the temperature necessary to produce the specified hardness and microstructure but not lower than 1100°F (593°C), holding at heat for not less than 6 hr, and cooling in air.

3.2.3.4 For steels other than AMS 6304, heat treatment shall be as agreed upon by purchaser and vendor.

3.2.3 Oxide and Decarburization Removal: The heat treated blanks, before cold working the fillet radius when specified and rolling the threads, shall have all surfaces free from surface oxide, oxide penetration, and decarburization except as permitted in 3.4.3.3 caused by prior heat treatment. The removal process shall produce no intergranular attack or corrosion of the blanks. The metal removed from the bearing surface of the head and the full body diameter of the shank shall be as little as practicable to obtain a clean, smooth surface and in no case shall be so great as to produce more cutting of flow lines in the head-to-shank junction of upset headed parts than shown in Fig. 1B.

3.2.4 Cold Working of Fillet Radius: After removal of oxide and decarburization as in 3.2.3, the head-to-shank fillet radius of parts having the radius complete throughout the circumference of the part shall, when specified, be cold worked sufficiently to remove all visual evidence of grinding or tool marks. Distortion due to cold working shall not raise metal more than 0.002 in. (0.05 mm) above the contour at "A" or depress metal more than 0.002 in. (0.05 mm) below the contour at "B" as shown in Fig. 2; distorted areas shall not extend beyond "C" as shown in Fig. 2. In configurations having an undercut associated with the fillet radius, the cold working will be required only for 90 deg of fillet arc, starting at the point of tangency of the fillet radius and the bearing surface of the head.

3.2.5 Thread Rolling: Threads shall be formed on the heat treated and finished blanks by a single rolling process after removal of oxide and decarburization as in 3.2.3.

3.3 Properties: Parts shall conform to the requirements of 3.3.1 and 3.3.2. Threaded members of Ø gripping fixtures for tensile tests shall be of sufficient size and strength to develop the full strength of the part without stripping the thread. The loaded portion of the shank shall have a minimum of two full thread turns from thread runout exposed between the loading fixtures during tensile tests. Finished parts shall be tested in accordance with the following applicable test methods of MIL-STD-1312:

Requirement	Test Method
Hardness	No. 6
Tensile Strength	No. 8

3.3.1 Tensile Properties:

3.3.1.1 Finished Parts: Parts having hardness as in 3.3.2 shall have breaking load not lower than that specified in Table II. If the size or shape of the part is such that failure would occur outside the threaded section but the part can be tested satisfactorily, such as parts having a shank diameter equal to or less than the thread minor diameter or having an undercut, parts shall conform to only the tensile strength requirement of 3.3.1.2; for such parts, the diameter on which stress is based shall be the actual measured minimum diameter of the part. Tension fasteners with either standard double-hexagon or hexagon-type heads having a minimum metal condition in the head equal to the design parameters specified in AS 1132 shall not fracture in the head-to-shank fillet radius except when this radius is associated with an undercut or with a shank diameter less than the minimum pitch diameter of the thread.

3.3.1.2 Machined Test Specimens: If the size or shape of the part is such that a tensile test cannot be made on the part, tensile tests shall be conducted in accordance with ASTM A370 on specimens machined from finished parts or from coupons of the same heat of steel heat treated with the parts. Such specimens shall meet the following requirements:

Tensile Strength, min	135,000 psi (931 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	15%
Reduction of Area, min	40%

3.3.1.2.1 When permitted by purchaser, hardness tests on the end of parts may be substituted for tensile tests of machined specimens.

3.3.2 Hardness: Shall be uniform and within the range 30 - 38 HRC or equivalent; hardness of the threaded section, and of the head-to-shank fillet area when cold working of this area is specified, may be higher than that of other areas as a result of the cold working operations.

3.4 Quality: Parts shall be uniform in quality and condition, clean, sound, smooth, and free from burrs and foreign materials and from internal and external imperfections detrimental to their performance. Parts shall conform to AS 1177.

3.4.1 Dimensional Examination: Parts shall conform to the following:

3.4.1.1 Straightness, Concentricity, and Squareness: Parts shall be within the limits of the drawing, determined in accordance with AS 3063.

3.4.1.2 Threads: Shall be as specified on the drawing and shall conform to AS 3062.

3.4.2 Macroscopic Examination: Parts or sections of parts as applicable, shall be ground, etched in a solution of approximately 50% hydrochloric acid (as gr 1.19) and 50% water for sufficient time to reveal flow lines but not longer than 15 min., and examined at approximately 20X magnification to determine conformance to the following requirements, except that examination for the thread imperfections of 3.4.2.3 may be made by microscopic examination of specimens polished and etched as in 3.4.3.

3.4.2.1 Flow Lines:

3.4.2.1.1 If parts have upset heads, examination of a longitudinal section through the part shall show flow lines in the shank, head-to-shank fillet, and bearing surface which follow the contour of the part as shown in Fig. 1A, except that slight cutting of flow lines by the oxide and decarburization removal process of 3.2.3 is permissible, as shown in Fig. 1B; excessive cutting of flow lines in the shank, head-to-shank fillet, and bearing surface, as shown in Fig. 1C, is not permissible except when an undercut is associated with the fillet radius. The head style shown in Figs. 1A through 1C is for illustrative purposes only but other symetrical head styles shall conform to the above requirements. Flow lines in upset heads on parts having special heads, such as Dee- or Tee-shaped heads or particularly thin heads, shall be as agreed upon by purchaser and vendor.

3.4.2.1.2 Flow lines in threads shall be continuous, shall follow the general thread contour, and shall be of maximum density at root of thread (See Fig. 3).

3.4.2.2 Internal Defects: Examination of longitudinal sections of the head and shank and of the threads shall reveal no cracks, laps, or porosity except laps in threads as permitted by 3.4.2.3.3 and 3.4.2.3.4. The head and shank section shall extend not less than D/2 from the bearing surface of the head and the threaded section shall extend not less than D/2 beyond the thread runout where "D" is the nominal diameter of the shank after heading. If the two sections would overlap, the entire length of the part shall be sectioned and examined as a whole.

3.4.2.3 Threads:

3.4.2.3.1 Root defects such as notches, slivers, folds, roughness, and oxide scale are not permissible (See Fig. 4).

3.4.2.3.2 Multiple laps on the flanks of threads are not permissible regardless of location. Single laps on the flanks of threads that extend toward the root are not permissible (See Figs. 5 and 6).

3.4.2.3.3 There shall be no laps along the flank of the thread below the pitch diameter (See Fig. 7). A single lap is permissible along the flank of the thread above the pitch diameter on either the pressure or non-pressure flank (one lap at any cross section through the thread) provided it extends toward the crest and generally parallel to the flank (See Fig. 7).

3.4.2.3.4 Crest craters, crest laps, or a crest lap in combination with a crest crater are permissible, provided the imperfections do not extend deeper than 20% of the basic thread height (See Table I), measured from the thread crest when the thread major diameter is at minimum size (See Fig. 8). The major diameter of the thread approaches maximum size, values for depth of crest crater and crest lap imperfections listed in Table I may be increased by 1/2 of the difference between the minimum major diameter and the actual major diameter measured on the part.

3.4.3 Microscopic Examination: Specimens cut from parts shall be polished, etched in 2% Nital, and examined at not lower than 100X magnification to determine conformance to the following requirements:

3.4.3.1 Microstructure: Parts shall have normalized and tempered structure with finely divided carbides. Ø Ferrite may be in a typical Widmanstatten pattern or randomly dispersed. Presence of tempered martensite, particularly in small diameter parts, will be acceptable.

3.4.3.2 Surface Hardening: Parts shall have no surface hardening except as produced during cold working of the head-to-shank fillet radius when specified and during rolling of threads. There shall be no evidence of carburization, recarburization, or nitriding. In case of dispute over results of the microscopic examination, microhardness testing shall be used as a referee method; a Vickers hardness reading within 0.003 in. (0.08 mm) of an unrolled surface more than 30 points higher than the reading in the core will be evidence of nonconformance to this requirement.

3.4.3.3 Decarburization:

3.4.3.3.1 The bearing surface of the head, the head-to-shank fillet radius, the shank and the threads shall be free from decarburization.

3.4.3.3.2 Depth of decarburization on those surfaces of the head which are the original surfaces of the bar shall be not greater than that permitted by the applicable material specification.

3.4.3.3.3 Depth of decarburization on the OD of the head of cylindrical head parts made by upsetting is not restricted.

3.4.3.3.4 Depth of decarburization at any point on any surface not covered by 3.4.3.3.2, 3.4.3.3.3, shall not exceed 0.002 in. (0.05 mm).

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of parts shall supply all samples and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.4. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to ensure that the parts conform to the requirements of this specification.

4.2 Classification of Tests: Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests.

4.3 Sampling: Shall be in accordance with AMS 2373.

4.4 Reports: The vendor of parts shall furnish with each shipment three copies of a report stating that the chemical composition of the parts conforms to the applicable material specification, showing the results of tests to determine conformance to the hardness and tensile strength requirements, and stating that the parts conform to the other technical requirements of this specification. This report shall include the purchase order number, this specification number and its revision letter, contractor or other direct supplier of material, part number, nominal size, and quantity.

4.5 Resampling and Retesting: If any part or specimen used in the above tests fails to meet the specified requirements, disposition of the parts may be based on the results of testing three additional parts or specimens for each origingal nonconforming specimen. Failure of any retest part or specimen to meet the specified requirements shall be cause for rejection of the parts represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Identification:

5.1.1 Parts having part numbers shall be packed in separate containers.

5.1.2 Each container of parts shall be marked to show the following:

FASTENERS, LOW-ALLOY, HEAT-RESISTANT STEEL
AMS 7454G
PART NUMBER_____
PURCHASE ORDER NUMBER_____
QUANTITY_____
MANUFACTURER'S IDENTIFICATION_____

5.1.3 Containers of parts shall be prepared for shipment in accordance with commercial practice to ensure carrier acceptance and safe transportation to the point of delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.1.4 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-794, Level A
Ø or Level C, as specified in the request for procurement. Commercial packaging as in 5.1.3 will be acceptable if it meets the requirements of Level C.

6. ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS: Parts not conforming to this specification or to authorized modifications will be subject to rejection.

8. NOTES:

8.1 Marginal Indicia: The phi (Ø) symbol is used to indicate technical changes from the previous issue of this specification.

8.2 For direct U.S. Military procurement, purchase documents should specify the following:

Title, number, and date of this specification
Part number or size of parts desired
Quantity of parts desired
Applicable level of packaging (See 5.1.4).

TABLE I

Threads Per Inch	Basic Thread Height Ref (See Note 1)		20% Basic Thread Height	
	Inch	(Millimetres)	Inch	(Millimetre)
80	0.0081	(0.206)	0.0016	(0.041)
72	0.0090	(0.229)	0.0018	(0.046)
64	0.0102	(0.259)	0.0020	(0.051)
56	0.0116	(0.295)	0.0023	(0.058)
48	0.0135	(0.343)	0.0027	(0.069)
44	0.0148	(0.376)	0.0030	(0.076)
40	0.0162	(0.411)	0.0032	(0.081)
36	0.0180	(0.457)	0.0036	(0.091)
32	0.0203	(0.516)	0.0041	(0.104)
28	0.0232	(0.589)	0.0046	(0.117)
24	0.0271	(0.688)	0.0054	(0.137)
20	0.0325	(0.826)	0.0065	(0.165)
18	0.0361	(0.917)	0.0072	(0.183)
16	0.0406	(1.031)	0.0081	(0.206)
14	0.0464	(1.179)	0.0093	(0.236)
13	0.0500	(1.270)	0.0100	(0.254)
12	0.0541	(1.374)	0.0108	(0.274)
11	0.0590	(1.499)	0.0118	(0.300)
10	0.0650	(1.651)	0.0130	(0.330)
9	0.0722	(1.834)	0.0144	(0.366)
8	0.0812	(2.062)	0.0163	(0.414)

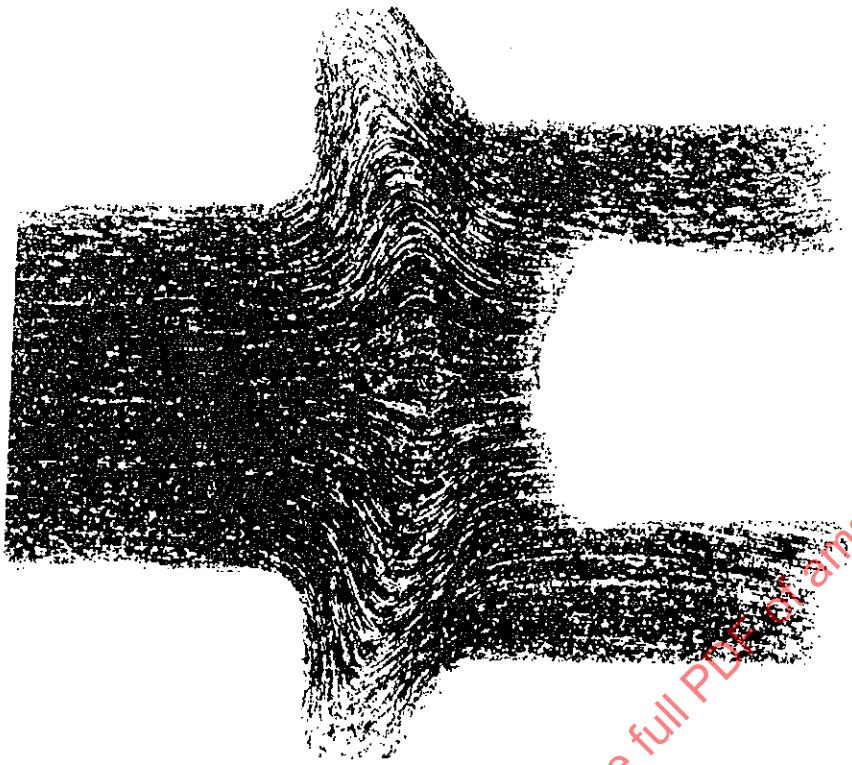
Note 1. Basic thread height is defined as being equivalent to 0.650 times the pitch.

TABLE II

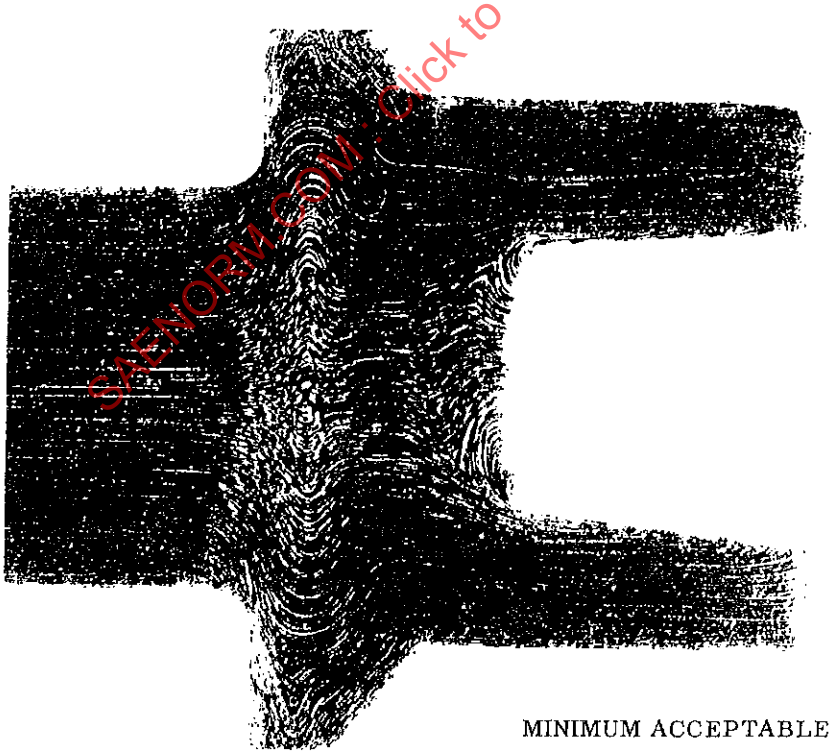
Bolt Size	Tensile Breaking Load, min			
	Standard Pitch Diam UN and UNJ Threads		Reduced Pitch Diam UN Threads Only	
	Pounds	(Newtons)	Pounds	(Newtons)
0.112-40	934	(4,150)	876	(3,900)
0.112-48	987	(4,390)	928	(4,130)
0.138-32	1,410	(6,270)	1,340	(5,960)
0.138-40	1,510	(6,720)	1,440	(6,410)
0.164-32	2,100	(9,340)	2,020	(8,980)
0.164-36	2,170	(9,650)	2,060	(9,160)
0.190-32	2,930	(13,000)	2,830	(12,600)
0.250-28	5,240	(23,300)	5,100	(22,700)
0.3125-24	8,300	(36,900)	8,120	(36,100)
0.375-24	12,800	(56,900)	12,600	(56,000)
0.4375-20	17,400	(77,400)	17,100	(76,100)
0.500-20	23,200	(103,000)	22,900	(102,000)
0.5625-18	29,400	(131,000)	29,000	(129,000)
0.625-18	36,800	(164,000)	36,400	(162,000)
0.750-16	53,400	(238,000)	52,600	(234,000)
0.875-14	72,800	(324,000)	72,300	(322,000)
1.000-12	94,900	(422,000)	94,000	(418,000)

Note 1. Requirements above apply to parts with UNC, UNF, UNJC, or UNJF threads, as applicable to the sizes shown, and having hardness as in 3.3.2; requirements for reduced pitch diameter parts are based on 0.003 in. (0.08 mm) reduction below standard. Area upon which stress is based is 98% of standard or reduced basic pitch diameter for nominal thread major diameters up to 0.3125 in. (7.938 mm) incl, and the standard or reduced basic pitch diameter for larger sizes. Tensile breaking load is based on 135,000 psi (931 MPa) stress.

Note 2. For sizes not shown, tensile breaking loads for parts tested as parts, not as specimens machined from parts or from coupons of the stock, shall be based upon the respective areas and stress given in Note 1 above.



SATISFACTORY GRAIN FLOW
FIGURE 1A



MINIMUM ACCEPTABLE STANDARD

Showing maximum permissible cutting of flow lines after machining to remove oxide and decarburization as in 3.2.3.

FIGURE 1B